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SECONDARY SEX ORGANS AND TAXONOMY IN THE NERITIDAE

BY E. A. ANDREWS

The grouping of snails within the family Neritidae has been based chiefly upon the characters of shell and of radula. However Bourne discovered in the several species that he studied that there were some anatomical differences within the family. Thus *Septaria* and *Neritina* agree in having both a coelomic funnel on the oviduct and also a *ductus enigmaticus,* while Nerita has the funnel but lacks the *ductus,* whereas *Theodoxus* lacks both funnel and *ductus.* That is, *Septaria* and *Neritina* are more alike while *Theodoxus* is a step farther than *Nerita* in the direction of diminished number of organs considered.

The present author has studied the secondary sex organs on the head of males and females and also the spermatophores and their organs for storage, as well as the contrivances for storage of mineral particles to be used by the females to add to the secreted capsules, within which the eggs undergo development.

Spermatophores are found stored up in many females during long periods and thus are to be found in museum specimens.

The detailed facts and the illustrations will appear elsewhere but some of the applications to the systematics of this family will be considered here. Though there are hundreds of species in this family the examination of but thirty may yet have significance since these species were taken at random and include seven genera of the nine recognized by Thiele (1929) and all the three subfamilies recognized by Baker (1923).

On attempting to fit the new facts into the accepted classification we at first meet with agreeable harmony. Thus *Neritilia succinea* differs much from the others: in the absence of both male and female head organs and of reinforcement sac (though

the capsule bears sand particles); in the absence of specialized anatomical connection of anus and ootype mouth though both are close together; and in the presence of long, slender, simple, tubular spermatophores. This is in harmony with the isolation given *Neritilia* by both Baker and by Thiele. Next *Smaragdia viridis* is set off as having anus and ootype separate and spermatophores slender tubes, in simplicity such as in *Neritilia.* But on the other hand it has a reinforcement sac (thus far found empty) as well as a female ridge and large male organ comparable to those of species of *Neritina.* On these accounts it might well be isolated as a separate subfamily, as done by Baker, or on the other hand, included with the other Neritinae, as done by Thiele.

When, however, we come to the subfamily, Neritinae, there is difficulty in putting new wine into old bottles and some new bottles may be needed. Thus *Nerita* in place of leading off from *Theodoxus* to form with it a division, *Neritae,* separated from the other genera, *Septaria, Neritina, Neritodryas* and *Pseudonerita,* seems to stand by itself, in having no female ridge; a simple straightforward male organ; only spherulites as contents of the reinforcement sac; no intimate union of anus and ootype mouth; rather uniform spermatophores of spindle form, with one coiled off end and one long open filament, as well as a spiral about its body and no triods; and in having a simple spermatophore-sac for temporary holding of spermatophores that may be cast out. Many of these features of *Nerita* are those of comparative simplicity and if regarded as primitive and not as secondary would tend to set off *Nerita* as a lower, more primitive form than *Neritina* or *Theodoxus* and not to be joined to *Theodoxus* in one group as done by Baker.

The other genera studied, *Neritina, Theodoxus, Septaria* and *Neritodryas* agree with one another and with the very exceptional *Nerita alticola* and *N. pupa,* in presenting: close fusion of anus and oviduct mouth; sand, or other foreign solids, in the reinforcement sac; transverse position and more or less elongation of the male head organ; presence of a female headridge; and specialization of the fundus of the vagina to form a lateral sac, in which spermatophores are held and digested. Yet in spermatophore form they differ much among themselves. *Neritina* often has

long loops with triods. *Theodoxus* has shorter loops but has also very short sac-like forms.

Nerita pupa appears to have short sacs like those of some *Theodoxus,* while *Nerita alticola* has a short sac with unique prolongations. The peculiarities of *Nerita alticola* and of *Nerita pupa* separate them from other *Nerita* and affiliate them with the *Neritina-Theodoxus* group so that, from the present point of view, they seem not in the genus *Nerita* at all. Their aloofness from other groups of *Nerita* is already recognized in placing them in the subgenera *Fluvinerita* and *Puperita.* In describing *N. alticola,* Pilsbry recognized its resemblances to other genera but concluded that on radular characters it should be a *Nerita.* Also *Nerita pupa* has some outward resemblance to *Neritina* and Baker says "it has remained in *Neritina* for over a century." It seems an error to have put it in *Nerita,* since from the sex organs it appears nearer to *Theodoxus;* and the same may be said of *Nerita alticola.*

It was shown that in the Neritidae the spermatophores, as far as known, may be grouped as simple long tubes, very long loops, shorter loops, spindles, and short sacs; and some of them have spirals and others have triods.

It is recognized that both spirals and triods are often difficult to observe in preserved material and here their apparent absence may be of no value in placing specimens, but when found they seem good characters. How would a grouping of snails of this family based upon spermatophores agree with one based upon radula characters?

Baker starts with the radula of *Neritina reclivata* as primitive type in the Neritidae. *Neritodryas* and *Pseudonerita* he regards as isolated. From *Vitta* he leads off *Neripteron, Vittina, Neritina* s.s. *Neritona* all on one branch, while the other branch would be *Clithon* s.s. *Alinoclithon, Neritoclithon, Theodoxus* s.s., leading to *Nerita.*

For the most part the spermatophores known fall well into this classification. Thus the specialized loop of *Vitta* is represented by loops in *Neripteron, Vittina, Neritina* s.s. and *Neritona* and they bear triods in *Vitta, Vittina,* and probably also in *Neritina* s.s. However *Neripteron* as represented by *Neritina vespertina*

has a spiral, as in *Nerita.* Then on the other branch, the spermatophore in *Clithon* has a very short sac-body with a shorter and a longer filament. This in *Vittoclithon* becomes apparently a mere sac, and this appears again in *Theodoxus* s.s. However *Alinoclithon* as represented by *Theodoxus cariosus* has a loop with a spiral, as in *Nerita.*

Thus the two lines of Baker based upon radula characters are also two lines as based upon spermatophore characters; loops in *Neritina* and sacs in *Theodoxus:* except that there are two species with spirals, one in each group, *Neripteron* and *Alinoclithon,* as represented by *Neritina vespertina* and *Theodoxus cariosus.* Although these two species stand in widely separated genera they resemble one another in that they have "somewhat similar shell form" (Baker); have spermatophores strikingly alike; and have male head organs very much alike and more complicated than in other species as far as known. The specimens used were taken together in an artificial fish pond close to the ocean, in Hawaii.

These two exceptional species form, as it were, a group by themselves and raise many questions. May it be that the expanded form of shell necessitates a more complex male organ? That shell form and male organ may be correlated is suggested by the conditions in Septaria and in *Theodoxus souleyetana* and *Th. madacassina* of the group *Clithon* in which some species may have spines over the outside of the shell which might necessitate elongated organs. Unfortunately there are no observations upon the handling of spermatophores in transit from male to female, but it may well be that one snail crawls upon the shell of the other and that the smoothness and thickness of shell as well as its slopes are of importance in enabling the organs to connect with one another.

If on the foundation of scanty facts yet known we were to fancy a family tree for the family Neritidae it would closely resemble in its branchings the grouping arrived at by Baker and followed by Thiele. The chief differences would be the isolation of *Nerita* and the emphasis placed upon the bastard nature of the so-called *Nerita alticola* and *Nerita pupa.* Also *Neritina virginea* would be on some accounts, *e.g.,* spermatophores, a highly evolved and not the primitive form that it appears to be from its radula.

Such a tree seen as a few top branches should have a very low branch for *Neritilia,* a somewhat higher one for *Smaragdia,* a separate old branch for *Nerita* and higher branches for *Neritodryas, Septaria, Theodoxus* and *Neritina.* Concealed amidst the top twigs of *Nerita* there might be branches known as *Nerita alticola* and *Nerita pupa* which in reality arose as "water shoots" from the bases of *Theodoxus* and *Neritina* branches and not from *Nerita.*

In time such a tree if well pruned and tended might represent a harmonious expression of facts known as to general anatomy, secondary sex organs, shell form, operculum characters and radula details in this family, Neritidae.

MOLLUSCA FROM PRINCE ALBERT NATIONAL PARK, SASKATCHEWAN

BY FRANK C. BAKER

The portion of Canada known as Saskatchewan is little known conchologically and additions to our knowledge of the mollusk fauna of this region are greatly to be desired. With the exception of two or three papers the only references to this region are contained in general papers on Canadian Mollusca or in descriptions of new species. During the summer of 1936, Professor T. D. A. Cockerell, of the University of Colorado, made a collection of Mollusca from several of the lakes in Prince Albert National Park near the center of Saskatchewan, at about 54 degrees of latitude. Professor Cockerell requested the writer to prepare a list of the species represented and the following lists indicates that the collection is unusually extensive.

Nine species of land mollusks and 21 species of aquatic mollusks are contained in the collection. The fauna is characteristically that of the northern part of the United States and southern Canada, quite different from the molluscan fauna of the Rocky Mountain region. It is more eastern than western, a feature also noted among certain insects and arachnids collected (see Cockerell, Canadian Ent., 68, p. 85, 1936). The avian and mammalian faunas are also of this nature. The land snails are such as are common in the northern part of the United States, all of